EHV

345 KV DOUBLE CIRCUIT TRANSMISSION

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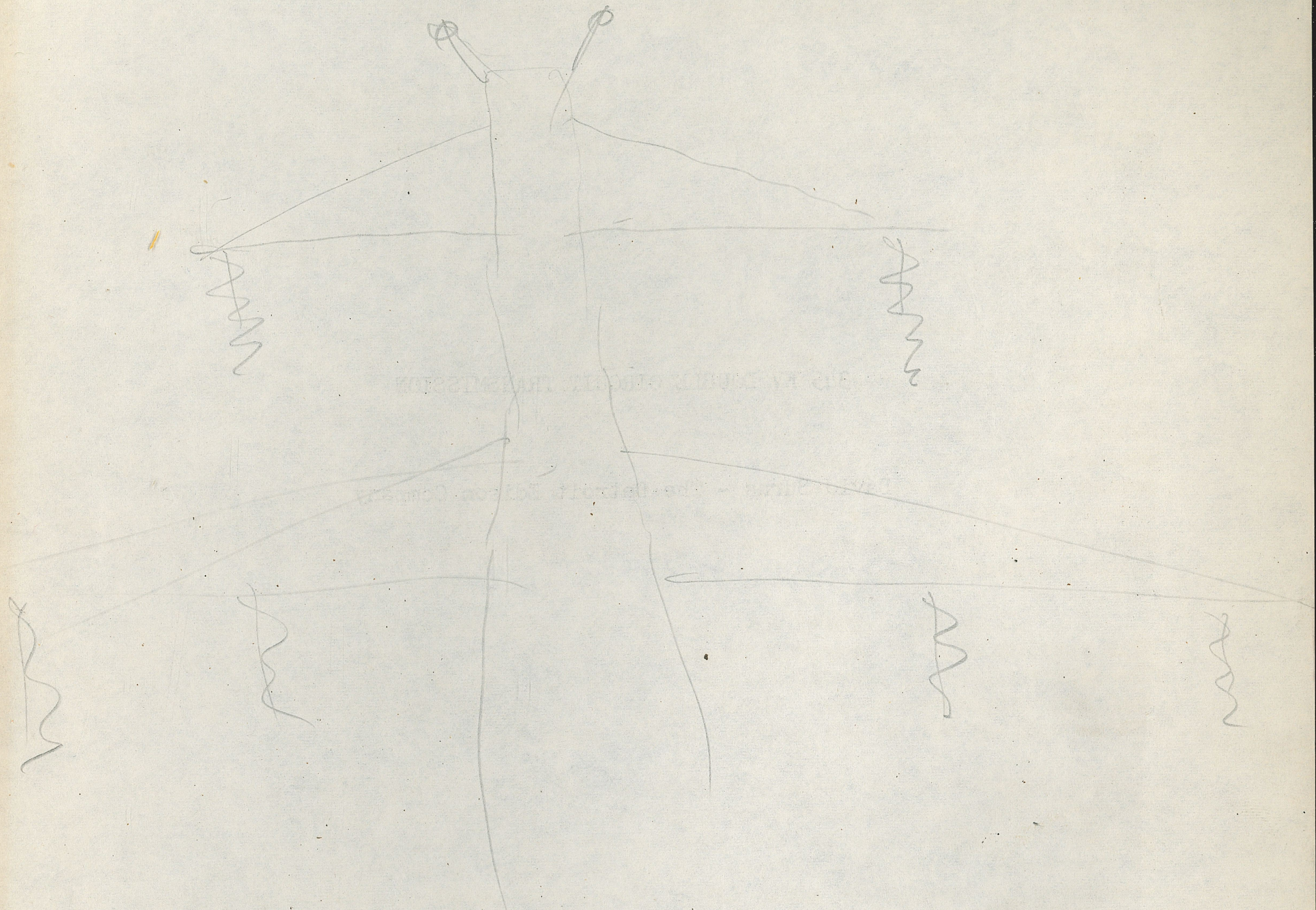

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Mr. Frank Sanford in his AIEE paper "Need for Research on Transmission Limitations", has forcefully called our attention to the need for additional engineering information on extra high voltage. This paper was published in the April Electrical Engineering.

My aim this morning is to tell you briefly the basis for our Company's decision to go to extra high voltage, describe the system arrangement and tower line construction.

At present our transmission network is 120 kv and connects six generating stations to load centers as shown on slide No. 1. The load requirements of the next ten to twenty years will require transmission for an additional million or more kilowatts from St. Clair plant. A similar increase in generation south of Detroit will require additions to transmission in that area, and of course an adequate tie between these two areas. It is obvious that at 120 kv many additional double circuit tower lines would be necessary. A goodly portion of the area transversed is now of a semi-urban character and right-of-way is a major problem. Public relations considerations as well as engineering economy call for higher voltage transmission.

Slide No. 2 shows the part of the proposed system to be built first. This portion will be operated temporarily at 120 kv. Economic studies showed the desirability of installing 345 kv insulation on original construction rather than add insulators later. These circuits at 120 kv are capable of carrying 300 mw each or 600 mw per double circuit tower line.

Operation of these new lines at 345 kv will take place when generation at one of the plants exceeds the capacity of the then existing 120 kv transmission system. We expect this to take place about 1964. Slide No. 3 shows the condition at that time. Slide No. 4 shows the 345 kv system as presently planned. This is scheduled for completion about 1975. The system shown on this slide pictures our recommendations based on availability of right-of-way and requirements of our operating people for service reliability. Of course changing conditions before 1975 will probably alter these plans somewhat.

In the course of our studies we visited extra-high voltage installations both in this country and Europe. Perhaps the most notable result of these consultations was our decision to use bundle conductors.

Double circuit towers will be used because of need to carry maximum load on any one right-of-way. We are aware that lightning outages on our proposed design will probably be more frequent than with horizontal single circuit on lower towers, but performance will still be reasonably good. Overall considerations, however, favor double circuit construction.

Four types of double circuit towers will be used - tangent, 12.5° angle, 30° angle and 45° angle. The latter tower, with minor changes in crossarms, can be used for deadends as well.

Tangent towers are designed for 1400 foot maximum straight line span under heavy loading conditions, or 900 foot span with 4° angle in the line. (Slide 5).

The 12.5° and the 30° angle towers of course will be used to handle medium line angles.

Slide No. 6 shows the 45° angle strain tower. Note the shortened footings on the compression side.

Main tower members are high strength alloy steel.

The 7'-0" offset between middle and upper arms is considered adequate to minimize the possibility of conductor contact resulting from dropping ice.

On the first line we have designed for a broken dual conductor. On future lines we are seriously considering the omission of the broken conductor requirement on the basis that breakage of both conductors in a bundle is remote except in the case of a catastrophe such as a plane in the line, in which case more conductors would likely be involved.

Conductors

Thermal capacity and radio influence voltage were the major factors in the choice of conductor. Two bundle 954 Mcm 45/7 ACSR (Rail) conductors will be used. Other conductors considered were single conductor 1.6" diameter, single 1.75" diameter expanded, two 954 Mcm 54/7, two 1012.5 Mcm 45/7, two 795 Mcm 26/7 and bundles of 3 or 4 smaller conductors. A considerable saving of money is realized by the use of the 954 Mcm 45/7 conductor instead of 954 Mcm 54/7. It is planned to pull conductors in under tension. Stringing tension at 60°F, will be 24%, and heavy loading tension will be 45%, respectively, of the ultimate tension of the conductor.

We have not decided definitely on all items of line hardware. Tapered armor rods will be used at suspension points, and vibration dampers at conductor deadends and possibly at other towers. Spacers will be installed approximately 225 feet apart between the dual conductors. Of various designs of spacers investigated three appear satisfactory; (1) preformed, (2) clamps with helical spring between, and (3) clamps with horizontally hinged bar. We may use all three types on the first line to obtain operating experience. Control rings will be used. The design and exact application is still being studied.

The problem of radio interference received major consideration because of the semi-urban nature of the transmission route. Much field and laboratory testing was done to assure us of a line that would not be objectionable to our customers. We expect few if any complaints with the use of the proposed two bundle 954 Mcm ACSR.

Tower spans average approximately 900 feet. Longer spans would require less tower steel, but the reduced spans permit lower towers and greater above ground clearance. These features are important to us. - the above ground clearance because of the semi-urban character of a large part of the route and lower towers to minimize lightning flashovers. Minimum ground clearance at 60°F over farm land in agricultural areas is 35 feet; greater clearance will be provided in semi-urban areas, orchards, etc. The shield wires will be sagged for 45.6% ultimate strength under Heavy Loading. Sag will be less than for line conductors; for example, final sags at 60°F, 900 foot span; conductor 20.7 feet, shield wire 15.7 feet.

Exclusive of right-of-way costs and general overhead expense the double circuit line will cost approximately $90,000 per mile.

Right-of-way is obtained both in fee and by easement. In agricultural areas easements are preferred, and we are securing these with 200 foot width for double circuit lines. In semi-rural areas where housing projects exist or are expected we frequently find it desirable to acquire the right-of-way in fee. In two locations we have purchased a 330 foot wide corridor ten miles long. This was in an area of potential housing developments where a second future line is planned.

This brief description of our 345 kv transmission design of necessity omits many details. If you have any questions I shall be glad to try to answer them.

DB/JP
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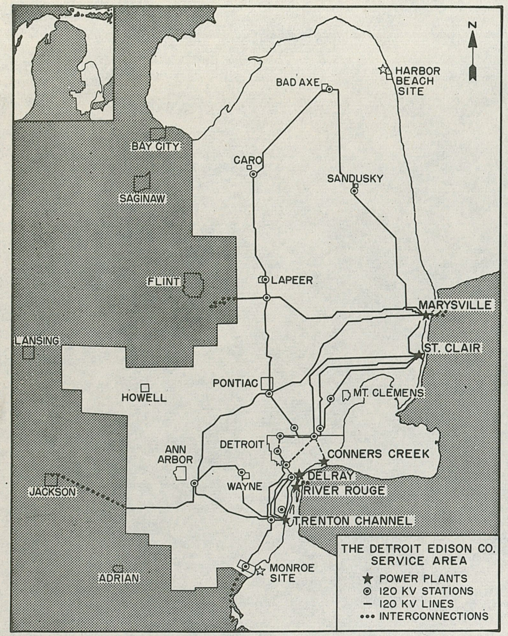
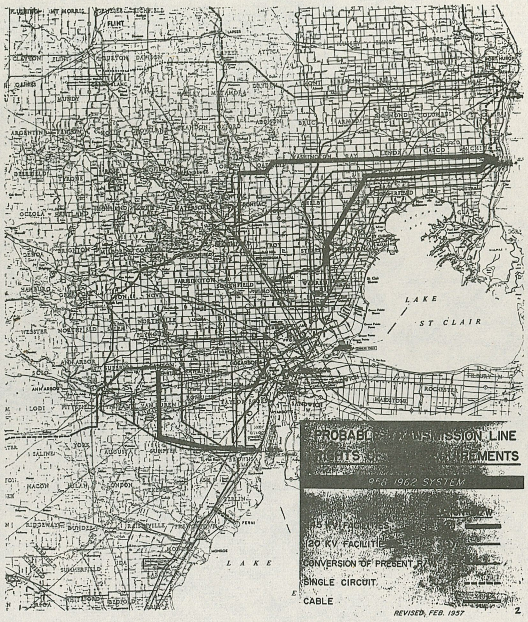
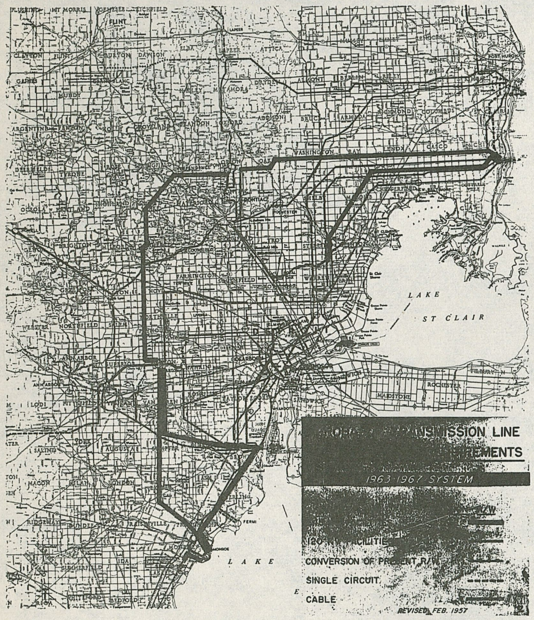


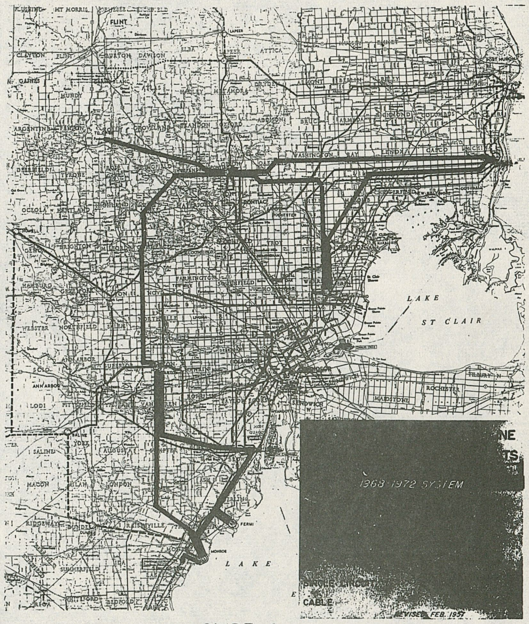
SLIDE 1



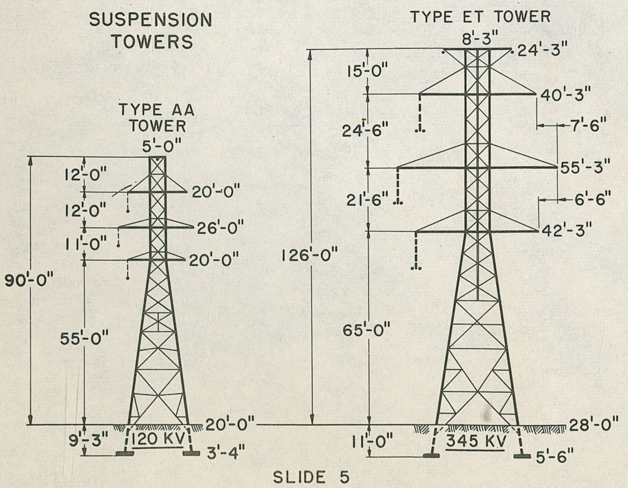
SLIDE 2



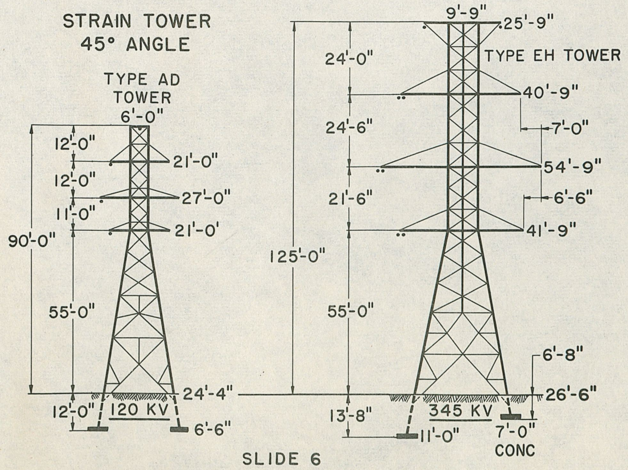
SLIDE 3



SLIDE 4



SLIDE 5



SLIDE 6